DTU Library

Integration of Polymer Micro-Electrodes for Bio-Sensing

Argyraki, Aikaterini; Larsen, Simon Tylsgaard; Tanzi, Simone; Taboryski, Rafael J.

Publication date:
2012

Document Version
Publisher's PDF, also known as Version of record

Citation (APA):
Argyraki, A., Larsen, S. T., Tanzi, S., & Taboryski, R. J. (2012). *Integration of Polymer Micro-Electrodes for Bio-Sensing*. Poster session presented at The Pittsburgh Conference on Analytical Chemistry and Applied Spectroscopy Inc., Orlando, Florida, United States.

DTU Nanotech
Department of Micro- and Nanotechnology

DTU

Integration of Polymer Micro-Electrodes for Bio-Sensing

Author: Aikaterini Argyraki

Supervisors: Simon Larsen, Simone Tanzi, Rafael Taboryski

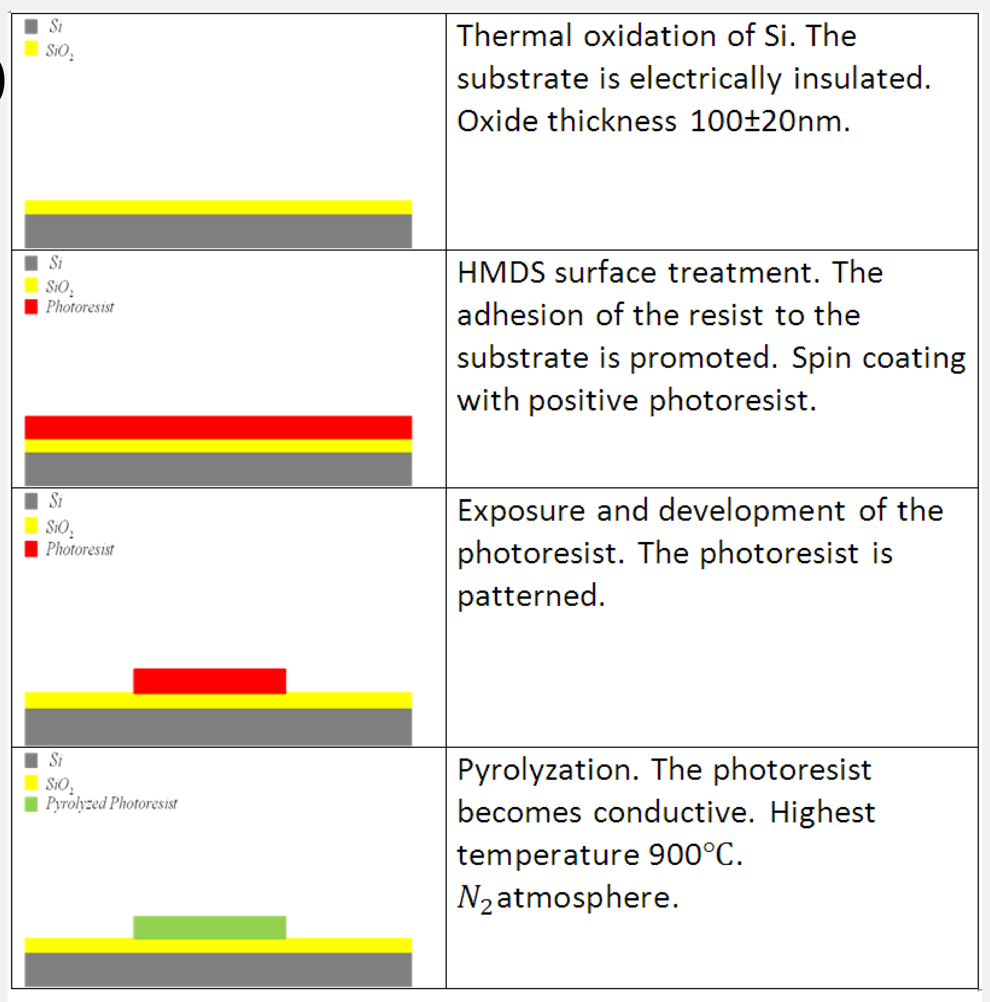
Objective

Single exocytotic events can be studied electrochemically with the use of microelectrodes. The goal of this project is to fabricate and integrate polymer microelectrodes on a polymer microfluidic chip for automated single cell exocytosis measurements.

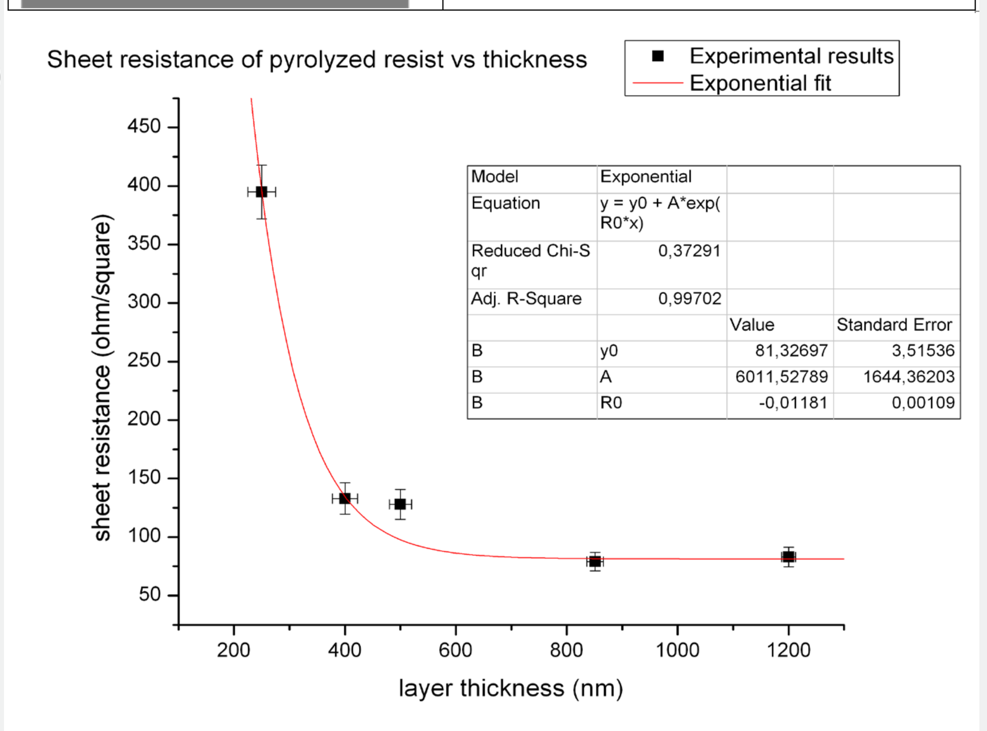
We present the fabrication of PEDOT and pyrolyzed micro-electrodes for the detection of neurotransmitter exocytosis from single cells. The patterns of the electrodes are defined with photolithography. The micro-electro-fluidic-chips were fabricated by bonding two injection molded TOPAS parts. Polymer electrodes integrated in polymer chips open the way for batch and low cost device fabrication.

Pyrolyzed photoresist microelectrodes

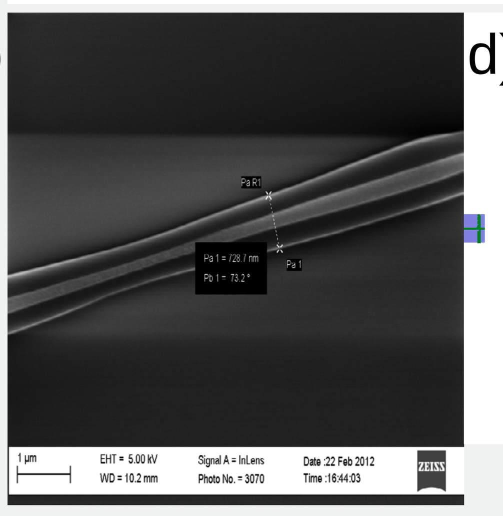
a)



b)



c)



d)

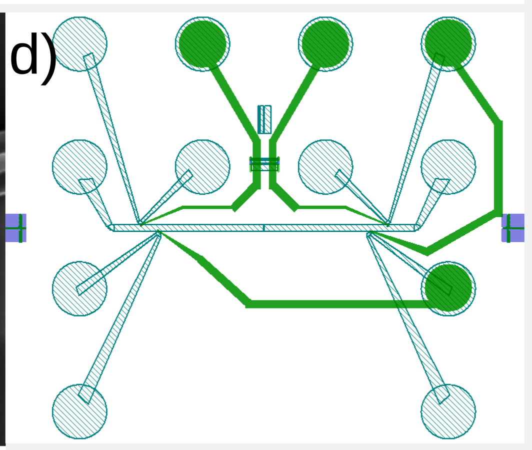
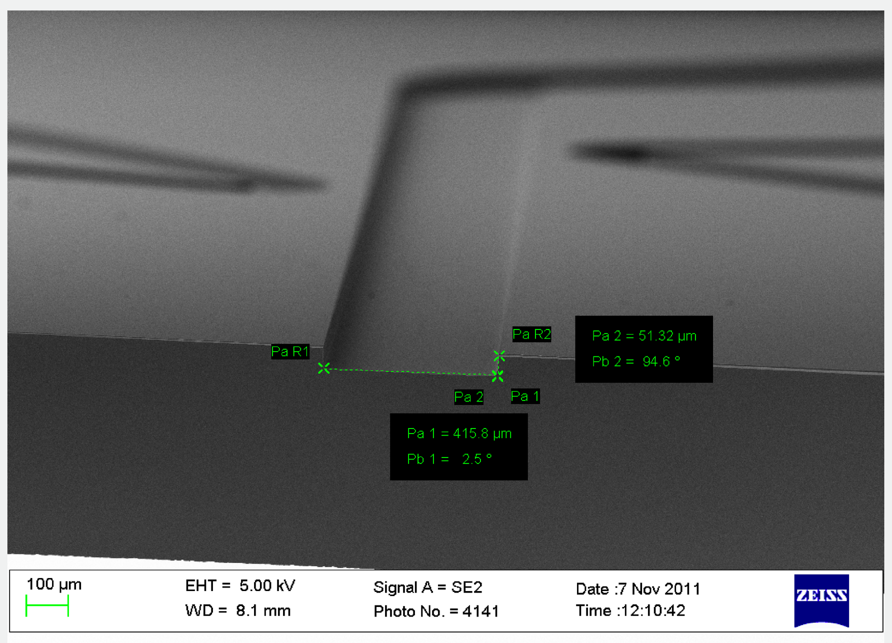


Figure 1: a) Fabrication process sequence of pyrolyzed microelectrodes. The resists used are AZ 5214 and AZ 4562. b) Sheet resistance of pyrolyzed resist versus layer thickness. The error bars are due to measurement uncertainties. c) SEM image of a pyrolyzed electrode. The deformed shape is a result of shrinkage effects during the pyrolysis process. d) Photomask designs for microchip and PEDOT microelectrode fabrication. Microfluidic channels are shown in white-green lines (50μm deep, 400μm wide). Electrodes are shown in green. The circles are illustrating Luer openings. The purple areas are indicating the alignment marks that are needed in order to align small channels on the electrodes. These small channels function as a bridge-connection between the microfluidic channels and their presence results in smaller active electrodes (see figure 2c).

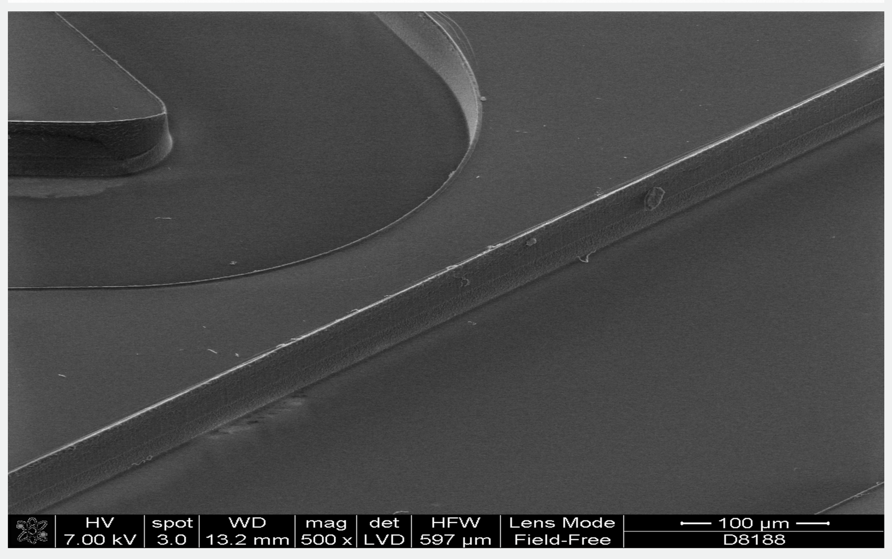
Chip fabrication

Micro-electro-fluidic-chips were fabricated by bonding two injection molded TOPAS parts. The top part contained microfluidic channels and Luer openings while the bottom part was patterned with PEDOT electrodes.

a)



b)



c)

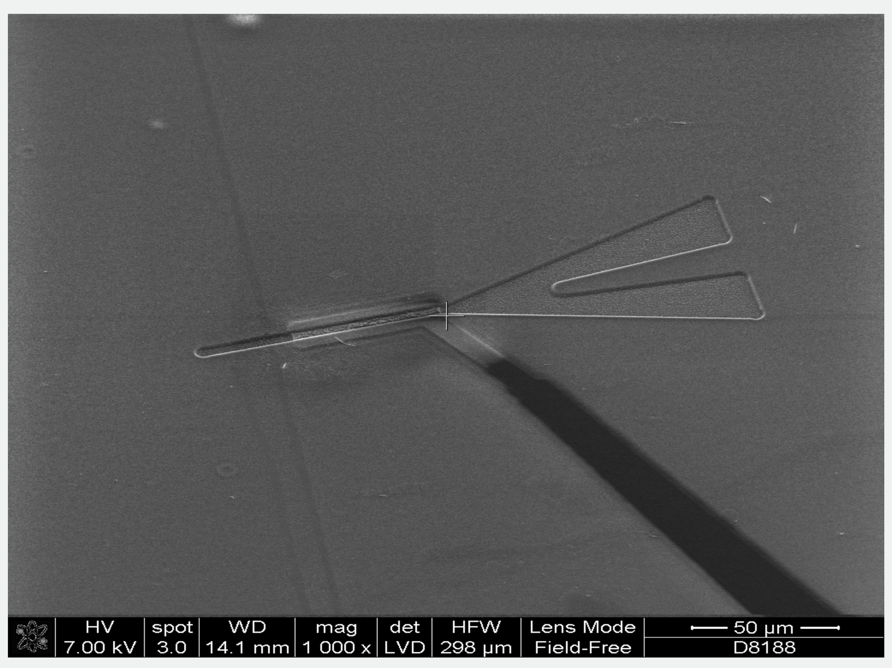


Figure 2: a) SEM image of a Silicon master stamp. The channels are created with deep reactive ion etching (DRIE). Resist was used as a masking material. The shim used for injection molding is fabricated by electroplating the Silicon master. b) SEM image of the injection molded microfluidic TOPAS chip. c) SEM image of the small channel (bridge-connection) on a PEDOT electrode. The small channel was created by etching the TOPAS flat substrate.

Results

The electrical properties of three materials were studied by cyclic voltammetry. The sheet resistance was measured with the 4 probe method and the layer thickness was approx. 190nm.

a)

	PEDOT: tosylate	PEDOT: PSS	Pyrolyzed photoresist
Sheet resistance (Ohm/square)	146 ± 25	1070 ± 306	395 ± 23
Capacitance per unit area ($\mu F/cm^2$)	1700 ± 100	651 ± 133	64 ± 10
Potential limits vs. Ag/AgCl (mV)	$[-200,700]$	$[-300,800]$	$[-300,1350]$

b)

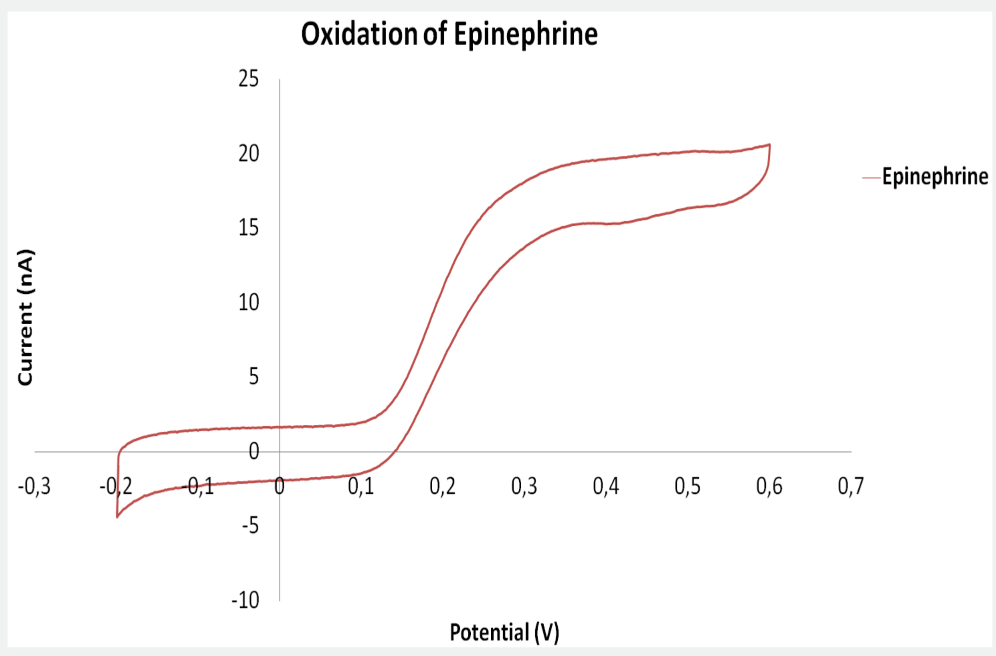


Figure 2: a) Summary table of the electrical properties of three conductive polymer materials. The capacitance of the electrodes was calculated by measuring the charging current at background cyclic voltammograms (PBS environment). b) Cyclic voltammogram demonstrating the oxidation of epinephrine on a pyrolyzed electrode. The electrode area was 20μm by 5000μm. The scan rate was 2mV/sec. The concentration of epinephrine was 20μM.

Perspectives

The integration of PEDOT electrodes on working biosensor devices has been demonstrated. Further efforts will be directed towards the integration of pyrolyzed polymer electrodes that have superior properties.

Aikaterini Argyraki
Master Student
aikar@nanotech.dtu.dk

DTU Nanotech
Department of Micro- and Nanotechnology
Technical University of Denmark
www.nanotech.dtu.dk

Supervisors
Simon Larsen, Simone Tanzi
Rafael Taboryski